

GETTING MECHANICAL ADVANTAGE

## All About Fishing and Marine Fisheries

Sport fishing is a great way to experience the ocean and to gain an appreciation for its incredible resources. Through this activity we can also come to see how the human body actually performs very much like the simple machines we use. Consider some basic fishing gear and techniques for casting a line and reeling it in.

Bones of the arm function as levers giving a mechanical advantage to you, just like the fishing rod that acts as an extension of your arm. Even the movement of body joints can be compared with simple mechanical devices. Think about how the humerus bone of your upper arm moves when you cast your line out into the water. It rotates inside the ball and socket joint of your shoulder, doesn't it? This is not too different than how the rotating cap on the handle of your fishing reel operates. Both allow for a full rotation of parts.

The human body is quite a machine! The hinge joint of your elbow carries out an action similar to the way the hinge on your tackle box moves, pivoting to open and close. And the sliding joint of the wrist

allows for side-to-side motion of your tiny wrist bones, just like the sliding lock on your tackle box. Sport anglers know that the action of the wrist when you make your cast is where you get that powerful "snap." That's the force that sends your baited hook far away from the side of the boat, jetty, or beach. Be sure to follow all posted fishing regulations. Overhead casting is prohibited on many municipal piers in California.

Anglers are naturally attracted by the lure of catching fish. A good angler can even tell you the species of fish they are hoping to catch. To be most successful, an angler must get to know the fishery. Did you know there is a separate and unique fishery for every species of fish caught as food for humans? There are also fisheries for fish that are harvested for purposes other than for humans to eat, such as for pet food. As you might imagine, the incredible variety of fish living in the ocean have very different needs and are found in very different places. Because of this, it takes a bit of learning to understand the fishery for the kind of fish you may want to catch.

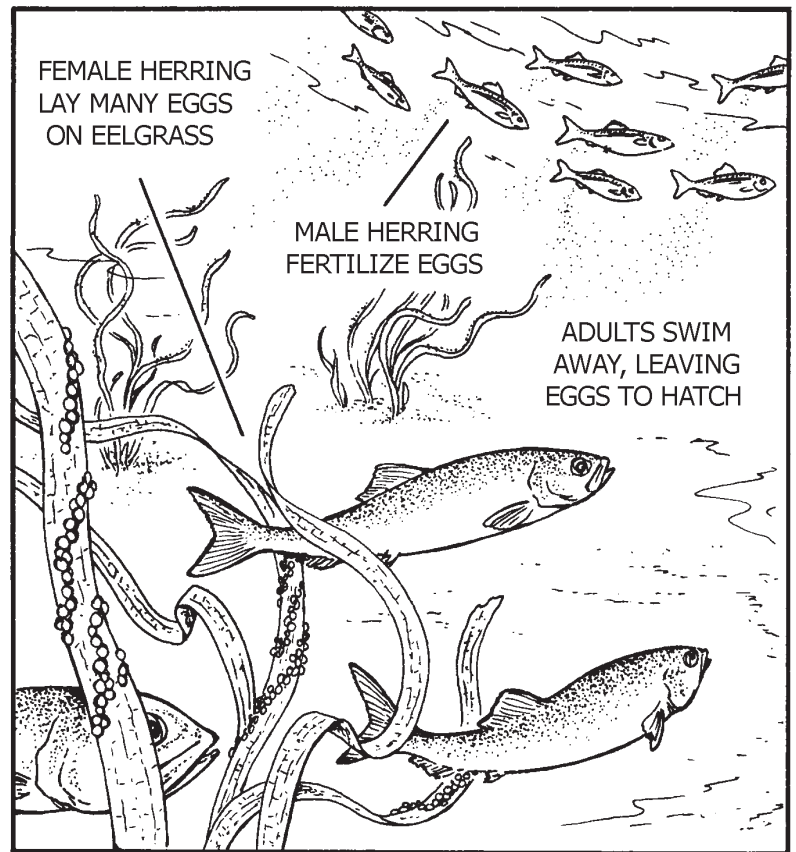
Each species has its own habitat and pattern for living including how deep in the water it may be found, how far it is likely to travel - by itself or in schools of fish, how and when it feeds, and, very importantly, where it is able to reproduce. The angler who knows the life history of the fish that he or she wants to catch knows where that species is likely to be found. The term 'fishery,' then, represents all the commercial and sport angler activity to catch or harvest from the population of a particular species in the habitat or 'fishing grounds' that is unique to that species. Let's explore a few of California's coastal fisheries.

## Return of the Herring

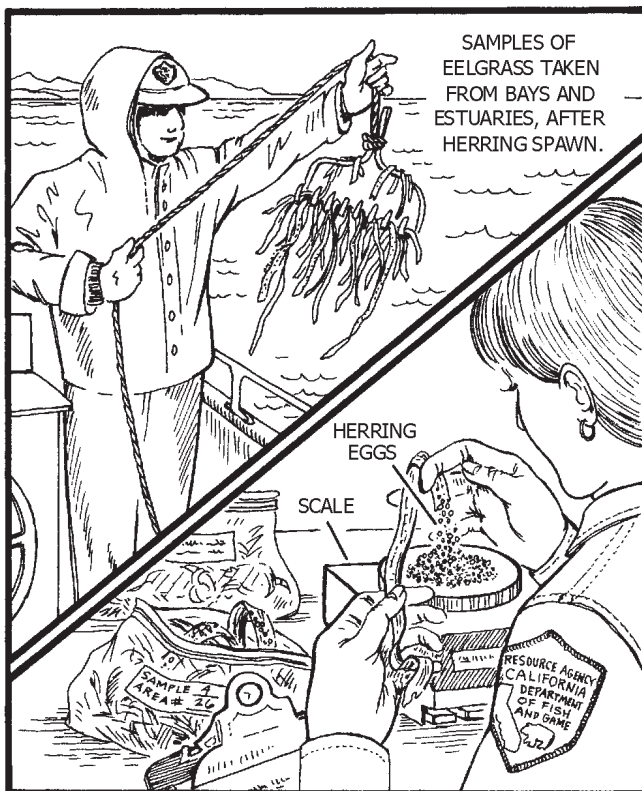
The herring fishery provides an example of a species that is known for a very simple reproductive strategy. Following the pattern of its spawning behavior is key to making a good catch for herring fishers. As you may know, the reproductive organs of the female generate eggs and male fish generate sperm that allow for external fertilization in most fish species. Once eggs are fertilized, however, certain species respond very differently when it comes to parenting tasks.

The herring fishery, centered in San Francisco Bay, is one of the state's most valuable fisheries. The juvenile fish are spawned in the protected waters of the bay in an amazing event that happens each year. Adult herring live their lives in open coastal waters of the Pacific Ocean, but they always return to the bay to lay and fertilize the eggs of the next generation.

Herring can live up to nine years and grow to a length of twelve inches. Fishermen prepare to capture the older fish that carry most eggs. The goal is to catch them before they spawn. This is because the herring eggs or "roe" is prized over and above the meat of the fish which is widely used for pet food. The brilliant yellow colored roe is enjoyed as a sushi delicacy in Japanese and U.S. markets. Packs of eggs are also wrapped as gifts and exchanged as a part of New Year's celebrations.



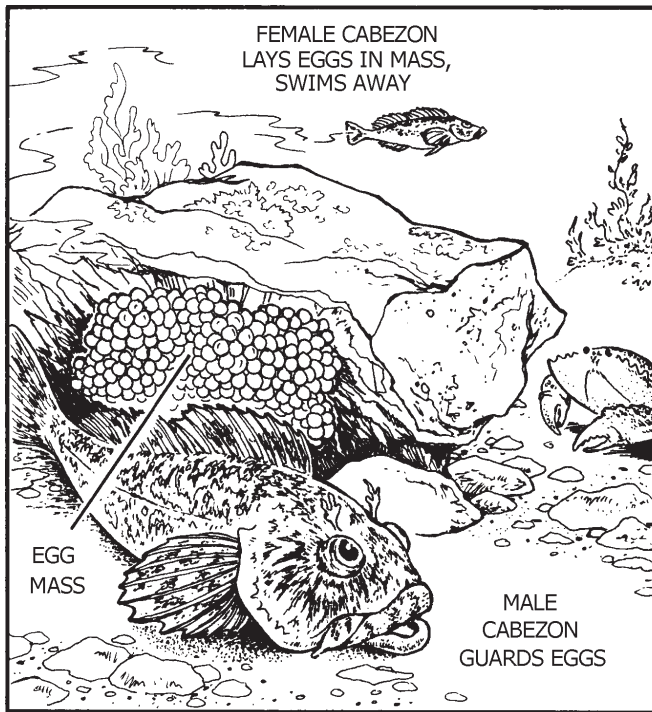
A SIMPLE REPRODUCTIVE STRATEGY



BIOLOGISTS MONITOR FISH POPULATIONS

Sometimes the larger herring are hard to find, depending on the season. The cold water herring has a tougher time finding the food sources to survive in years when El Nino current pushes warmer waters further to the north. Their numbers are often a sign of ocean productivity. Herring do well and ocean productivity is high when the volume of tiny zooplankton (their main food source) goes up. When ocean productivity is low and the volume of zooplankton is down the herring population also falls.

Roe can be removed from the fish or harvested from kelp fronds where much of it is deposited by the females. A female can lay 45,000 eggs that stick to many different surfaces including kelp, eel grass, rocks, pier pilings, and boat bottoms. Males swim above while eggs are deposited fertilizing them with their milt. This is a very simple reproductive process. After spawning has taken place neither parent sticks around to watch the young hatch out. The development of eggs takes place in about ten days without any help or concern at all from male or female.



KEEPING WITHIN A SMALL RANGE

The simple reproductive strategy of herring provides a good contrast to that of a more solitary groundfish such as the cabezon. While the sheer number of eggs produced by a female cabezon is much smaller than the herring, cabezon have a completely different reproductive strategy that often ensures a higher survival rate of developing young. The secret involves good parenting. Unlike the far-roaming herring, a cabezon rarely strays from a narrow range of habitat. Once the egg mass is deposited male cabezon stay nearby the vulnerable eggs and keep potential predators away. The unique adaptive strategies shown by different species of fish are really quite amazing.

When herring return to the bay for spawning they gather in large masses. One of the largest schools ever measured by Fish and Game biologists stretched fifteen miles across the bay! Herring provide a primary food source for many birds, mammals and larger fish. At spawning time in San Francisco Bay the scene can be quite noisy with gulls fighting over fish and sea lions barking with the excitement of lots of catch.

## Not Just Fish in a Fishery

California's market squid, popularly known as "calamari," is a delicacy food among Americans and is also a popular international export. The squid fishery has often been state's largest since 2000, both in terms of volume and monetary value. 160 million pounds of California squid were landed in 2002 valuing more than \$18 million.

Resembling a streamlined octopus, the squid grows to a length of 12 inches, including its eight arms and two feeding tentacles. This edible mollusk is quite a tasty meal for humans and many more. California's squid resource is not only valued for its national and international sales, it is also used as bait for sport fishing, and provides essential food for seabirds, marine mammals and a wide variety of ocean fishes.

A Market Squid Fishery Management Plan has been developed under provisions of California's Marine Life Management Act, which became law in 1999. The MLMA created state policies, goals, and objectives to govern the conservation, sustainable use, and restoration of the state's living marine resources such as the squid resource.

Fishing vessels target schools of squid that have come together in shallow water areas (50 to 150 feet deep) to spawn. Operating at night, one boat is often used to attract squid to the surface using strong lights while a second vessel uses what is called a round haul net or purse seine to catch them.



NIGHT FISHING FOR SQUID



Management tools include establishment of fishery harvest control rules including a seasonal catch limitation to prevent the fishery from over-expanding and restricting access to the fishery by issuing permits. Gear regulations on light shields and wattage used to attract squid are also imposed to protect nesting seabirds and reduce impacts on coastal communities.

### Case Study Points to Fishery Management Need

Sardines are small pelagic fish that live and move in open ocean waters. They are also members of the herring family. Pacific sardines that are typically harvested are less than 12 inches in length and up to 8 years old. Most sardines in the historical and recent commercial catch were five years and younger. Sardines are filter feeders and prey on crustaceans, mostly copepods, and other plankton, including fish larvae and phytoplankton.

The first half of the 20<sup>th</sup> century (1900 – 1950) has been called the golden years of California ocean fishing. During this period, the Pacific sardine supported the largest fishery in the Western Hemisphere. In 1936, the catch peaked at over 700,000 tons. California processors began as canners, getting the harvest preserved for humans to eat. By 1945, at the end of the Second World War, the canneries in Monterey's historic Cannery Row were humming with activity.



HISTORIC PROCESSING AT A MONTEREY BAY CANNERY

As with any resource that is dependent on the fluctuating variables of a natural support system such as the sea, there is a limit to how much can be harvested without having a negative impact on the future of the resource. The history of the sardine fishery provides a good case study of what can result when a boom-to-bust pattern of resource harvest is pursued.

Throughout the middle of the 20<sup>th</sup> century, sardine processing expanded with production of fishmeal and oil – even while the number of landings (number of fish caught) was declining. Eventually, a very lucrative market for sardines as dead bait developed in central California and was primarily responsible for continued fishing on the depleted resource. Within a period of thirty years the fishery had collapsed to less than 1,000 tons per year in the late 1960s.

While natural oceanic and climatic occurrences are known to factor in the cycles of decline and recovery of population levels, in the case of the Pacific sardine, human activities have played a major role. In recent years, it has been shown that recovery of fisheries such as the sardine are achievable through active fisheries management. This includes scientific monitoring over time and regulation of harvest that balances human needs for food and commerce with conservation of the fishery resource for future generations. Today, the fishery for Pacific sardine has fully recovered and is under careful monitoring.